Fabrication of long wavelength array by in-situ molecular beam epitaxy
Monthly report No. 4
(contract No. DAAB07-91-C-K762)

1.0 Progress status

During this program period, we have performed large area growth of device-quality InAsSb films on 2-inch Si substrates. We have fabricated InAsSb films of uniform thickness, which are suitable for dense detector arrays. To obtain higher quantum efficiency, a pin structure for LWIR detector has been proposed and delineated. Results obtained in the last month are presented and discussed in the following sections.

2.0 Epitaxy of InAsSb on 2-inch Si substrates

We have grown several InAsSb epilayers on 2-inch Si substrates, to test the capability of large area epilayer growth in our laboratory. The arrows in Fig. 1 indicate an 1.8 inch round size of mirror-like InAsSb film. The thickness uniformity across the film surface, shown in Fig. 2, is of the order of 6%. The uniformity in thickness can be improved further when the rotation of the substrate is implemented during the growth. The measured carrier mobility was 1.5×10^4 cm^2/V-s and carrier concentration was 8.7×10^{16} cm^{-3} at liquid nitrogen temperature.

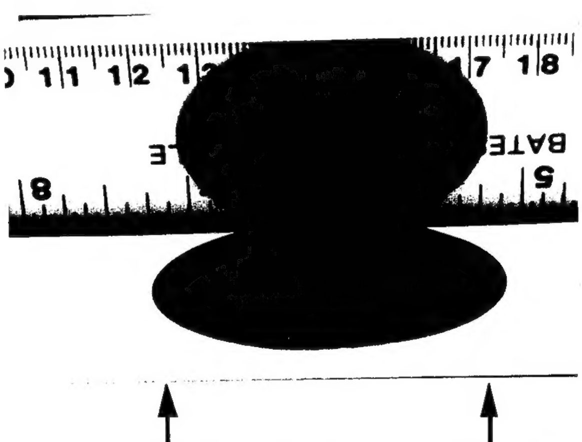

Fig. 1 A photograph of InAsSb epilayer on a 2-inch Si substrate.

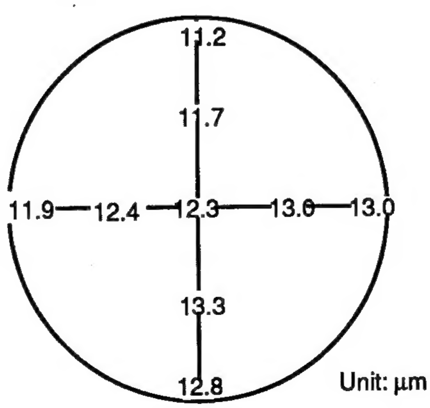

Fig. 2 Distribution of film thickness across a 2-inch wafer of InAsSb on Si.

3.0 Delineation of the LWIR detector structure

A pin detector structure (rather than a pn structure) has been proposed for higher quantum efficiency. The band structure of the proposed pin detector is shown in Fig. 3. The key parameters of the pin structure for LWIR detectors are listed in Table 1. To realize a cutoff wavelength above 10 μm, it needs to have a 90%(or less)-Sb composition of constituent layers of InAsSb/InSb SSL (the "i" region) in the pin detector structure. Also, the thicknesses of these constituent layers of InAsSb/InSb SSL will be kept less than the critical thickness of 250Å to prevent occurrence of defects. To optimize quantum efficiency, we will fabricate the "i" region with a thickness of less than 0.5 μm, which is the minority carrier diffusion length. Similarly, the "p" (and "n") region of the pin structure will be processed with p-type (and n-type) doping concentration in excess of 10^{18} cm^{-3}.

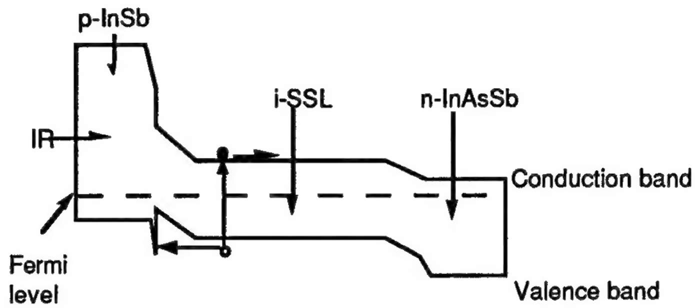

Fig. 3 Band diagram of proposed pin structure for the LWIR detector.

Table 1 Key parameters of the proposed pin structure above.

	layer	thickness (μm)	Carrier concentration (cm^{-3})
p	InSb	5.0	10^{18}
i	InAsSb/InSb SSL	0.5	10^{16}
n	InAsSb	5.0	10^{18}

4.0 Conclusions

During the last month, high-quality and large-area InAsSb epilayers have been successfully grown on Si substrates in our laboratory. The high thickness-uniformity of InAsSb epilayers obtained leads to the feasibility of dense LWIR detector array fabricated on Si substrates. A pin structure for a LWIR detector has been proposed and the key fabrication parameters of the detector have been delineated. The tasks set for this period were completed as planned.